

Remarks/Arguments

Claim 80 has been added. Claim 56 has been canceled. Claim 79 has been amended. Claims 1-31, 33-55 and 57-80 are in the application upon entry of this amendment. Entry of this amendment and reexamination and reconsideration of the present application are respectfully requested.

The Applicants acknowledge with thanks the Examiner's finding that claims 73 and 74 are allowed.

Claim 56 has been objected to as being dependent on a rejected base claim, but would be allowable if rewritten in independent form. In response, claim 56 has been canceled, and rewritten in independent form as new claim 80. Applicants respectfully submit that claim 80 is allowable.

Claim 78 has been rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Specifically, the Examiner contends that claim 78 specifies "wherein a first heat exchange fluid flows in the first set of heat exchange channels . . . and another heat exchange fluid flows in the another set of heat exchange channels . . . the first heat exchange fluid being . . . different than the another heat exchange fluid" does not appear to have support in the specification. The Examiner requested that the Applicants point out where support for this language could be found. In response, Applicants respectfully submit that the foregoing passage is supported in the specification at page 29, lines 11-30. Claim 78 is in full compliance with 35 U.S.C. §112, first paragraph, and withdrawal of the rejection is believed to be warranted and is respectfully requested.

Claim 79 was objected to because the claim was missing a period at the end of the claim. In response, claim 79 has been amended to add a period at the end of the claim.

Claims 1-29, 31, 33-51, 54, 55, 57-59, 62-64, 69-72, 75, 78 and 79 have been rejected under 35 U.S.C. §103(a) as unpatentable over TeGrotenhuis(WO 03/078052 A1), Tonkovich '408 (U.S. 7,470,408) and Brophy (U.S. 7,118,920). Claims 52 and 53 have been rejected under 35 U.S.C. §103(a) as unpatentable over TeGrotenhuis, in view of Tonkovich '408, Brophy and Reyes (U.S. Patent 6,726,850). Claims 60, 61 and

76 have been rejected under 35 U.S.C. §103(a) as unpatentable over TeGrotenhuis, in view of Tonkovich '408, Brophy and Ghosh (U.S. 5,961,932). Claims 30, 65-68 and 77 have been rejected under 35 U.S.C. §103(a) as unpatentable over TeGrotenhuis in view of Tonkovich '408, Brophy and Tonkovich '647 (U.S. 7,029,647). These rejections are respectfully traversed.

The citation of Tonkovich '408 and Tonkovich '647 in the above-indicated rejections, which are based on 35 U.S.C. §103(c), is improper under 35 U.S.C. §103(c) due to the fact that each of these references is prior art under 35 U.S.C. §102(e)(2) only, and each of these references is assigned to the same party (Velocys, Inc.) as the present application. Tonkovich '408, which issued December 30, 2008, was based on an application filed May 17, 2004 (but as noted by the Examiner claimed priority to a provisional application filed on December 18, 2003). Tonkovich '647, which issued April 18, 2006, was based on an application filed January 27, 2004. Both Tonkovich '408 and Tonkovich '647 had effective filing dates that were prior to the filing date of February 11, 2004 for the present application, but issue dates that were subsequent to the filing date of the present application, and as a result both Tonkovich '408 and Tonkovich '647 are prior art against the subject application under 35 U.S.C. §102(e) only.

The present application, and Tonkovich '408 and Tonkovich '647, are commonly assigned. The assignee for each of these is Velocys, Inc. The assignment for the present application was recorded on June 14, 2004 at reel/frame 015461/0406. The assignment for Tonkovich '408 was recorded September 27, 2004 at reel/frame 015827/0672. The assignment for Tonkovich '647 was recorded on June 17, 2004 at reel/frame 014741/0531.

Since both Tonkovich '408 and Tonkovich '647 are prior art to the present application under 35 U.S.C. §102(e) only, and since both of these references and the present application are commonly assigned, under the provisions of 35 U.S.C. §103(c), neither of these references is citable against the present application under 35 U.S.C. §103(a). Accordingly, withdrawal of the rejection of claims 1-31, 33-55, 57-72 and 75-79 under 35 U.S.C. §103(a) based on the teachings in Tonkovich '408 is believed to be

warranted and is respectfully requested. Similarly, withdrawal of the rejection of claims 30, 65-68 and 77 under 35 U.S.C. §103(a) based on the teachings in Tonkovich '647 is believed to be warranted and is respectfully requested.

The rejection of claims 1-29, 31, 33-51, 54, 55, 57-59, 62-64, 69-72, 75, 78 and 79 under 35 U.S.C. §103(a) is based on TeGrotenhuis in combination with Tonkovich '408 (which is not available as a reference) and Brophy. In the rejection of claims 52 and 53, Reyes has been combined with the foregoing references. In the rejection of claims 60, 61 and 76 Ghosh has been combined with TeGrotenhuis, Tonkovich '408 and Brophy. In the rejection of claims 30, 65-68 and 77, Tonkovich '647 (which is not available as a reference) has been combined with TeGrotenhuis, Tonkovich '408 and Brophy. With each rejection, the Examiner has discussed each reference individually, but has not provided any rationale as to why the teachings in the references were combined. Since the Examiner has not provided any rationale for combining the references, the rejections are not valid. See, Section 2141 of the MPEP, and the Federal Register, Vol. 75, No. 169, September 1, 2010, pages 53643-53660, "Examination Guidelines Update: Developments in the Obviousness Inquiry After KSR v. Teleflex" where the Patent Office requires that when references are being combined a rationale for that combination must be indicated. Withdrawal of each of the foregoing rejections under 35 U.S.C. §103(a) is believed to be warranted and is respectfully requested.

Even if the various combination of references selected by the Examiner were proper, however, the teachings in these references would not be sufficient to render the Applicants' claims 1-31, 33-55, 57-72 and 75-79 unpatentable. TeGrotenhuis discloses a microchannel device wherein a reaction chamber is in thermal contact with a heat exchange channel. The microchannel device is illustrated in Fig. 9. Referring to Fig. 9, the device includes reaction flow path 51 and heat transfer channel 61, either or both of which may include microchannels. Reactants flow through the reaction flow path from inlet 53 to outlet 55. Reaction chamber 52, which is defined by the presence of catalyst 75, can span some or substantially all of the length of the flow path 51. Heat exchange fluid flows through the heat exchange channel 61 from inlet 63 to outlet 65. Solid wall

70 separates the heat exchange channel 61 from the reaction chamber 52. TeGrotenhuis does not suggest the use of two or more separate reaction zones in the reaction flow path 51. This is admitted by the Examiner. In contrast, the Applicants' independent claims 1, 69, 78 and 79 specify "a first reaction zone" and "another reaction zone" in the same process microchannel.

The Applicants' independent claims 1, 69, 78 and 79 specify the employment of heat exchange channels for exchanging heat with the reaction zones wherein a heat exchange fluid in the heat exchange channels undergoes a phase change. The employment of heat exchange fluid that undergoes a phase change enhances the heat transfer between the reaction zones and the heat exchange channels beyond that provided by convective heating or cooling. For example, for a liquid heat exchange fluid being vaporized additional heat is transferred from the reaction zones as a result of latent heat of vaporization required by the heat exchange fluid. See, Applicants' specification at page 46, lines 25-31. This is not suggested by TeGrotenhuis.

Claim 78 is directed to a process for conducting an equilibrium limited chemical reaction in a microchannel reactor employing a first reaction zone and another reaction zone wherein the first reaction zone is heated or cooled by a first set of heat exchange channels and the another reaction zone is heated or cooled by another set of heat exchange channels. The first set of heat exchange channels is separate from the another set of heat exchange channels. This is not suggested by the teachings in TeGrotenhuis

Claims 2-31, 33-55, 57-68 and 75-77 depend from claim 1 and are distinguishable from the teachings in TeGrotenhuis for at least the same reasons as claim 1. Claims 70-72 depend from claim 69 and are distinguishable from the teachings in TeGrotenhuis for at least the same reasons as claim 69.

The Examiner contends that TeGrotenhuis "teach a process for oxidation (page 27) wherein the reactions are equilibrated to 90% conversion (page 13) and plural fins coated with catalysts (fig. 10, #164), are used in the process (page 26) wherein the multiple microchannels have temperatures around 300°C (page 31)." Applicants respectfully disagree with these contentions. The process disclosed on page 13 of

TeGrotenhuis where a 90% conversion is referred to is a water gas shift (WGS) reaction, not an oxidation reaction as indicated by the Examiner. Also, the process disclosed on page 31 where a 300°C temperature is referred to is a WGS reaction.

The 90% conversion referred to on page 13 of TeGrotenhuis was taken from the plot shown in Figure 1 which is for a WGS reaction. This plot indicates that the reaction rate for the WGS reaction dropped “by over three orders of magnitude by the time 90% conversion is reached.” See, TeGrotenhuis at page 13, lines 17-22. The 90% conversion value referred to in this passage is not the same as the “approach to equilibrium” which is specified in the Applicants’ independent claims 1, 69, 78 and 79. The term “approach to equilibrium” is defined in the Applicants’ specification at page 20, line 35 to page 21, line 9, as being the actual conversion of a reactant divided by the equilibrium conversion for that reactant.

The Examiner’s contention that TeGrotenhuis discloses “sequential reactors, having ribs formed of catalyst (Fig. 10, #164)” is not correct. The cited passage from TeGrotenhuis discloses a method for making a microchannel reactor, but does not suggest the use of sequential reactors as contended by the Examiner. In Figs. 8 and 10-12, TeGrotenhuis discloses microchannel reactor 100 which includes reactant inlet 110, reactant outlet 120, heat exchange fluid inlet 130 and heat exchange fluid outlet 140. Reactor 100 is constructed by alternatively stacking a series of shim sheets designated A (Fig. 10), B (Fig. 11) and C (Fig. 12). The shim sheets A, B and C contain channel features and when assembled provide a stacked array of microchannel flow paths in reactor 100. Each of the shim sheets A, B and C contains three identical shim patterns so that three reactors 100 can be constructed from the shim sheets. See, TeGrotenhuis at page 20, line 8 to page 21, line 4. The cited passage does not suggest the use of sequential reactors as contended by the Examiner.

The Examiner admitted that TeGrotenhuis fails to teach that the heat exchanger comprises a heat exchange fluid undergoing a phase change in the heat exchange channels. To make up for this deficiency, the Examiner cited Brophy. Brophy discloses a microchannel apparatus for conducting multiphasic reactions. The reference indicates that microchannel or non-microchannel heat exchangers may be used with the

apparatus. These heat exchangers employ a heat exchange fluid which is described in Brophy as follows (column 12, lines 54-58):

The heat exchange fluids can be gases or liquids and may include steam, liquid metals, water, Therminol®, mineral oil, silicone oil, brine, or any other known heat exchange fluids – the system can be optimized to have a phase change in the heat exchanger.

Based on upon the above-indicated disclosure in Brophy, the Examiner contends that it would have been obvious to employ a heat exchange fluid that undergoes a phase change as specified in the Applicants' independent claims 1, 69, 78 and 79. Brophy does not, however, provide any disclosure that would make up for the deficiencies in TeGrotenhuis that would be sufficient to render independent claims 1, 69, 78 and 79 unpatentable. Brophy provides no disclosure relating to determining the equilibrium conversion value for a reactant and conducting the reactant in a microchannel wherein a first reaction is conducted in the first reaction zone of a microchannel at a first reaction temperature and then another reaction is conducted in another reaction zone in the microchannel at another temperature, as specified in the Applicants' independent claims 1, 69, 78 and 79.

The Examiner cites Reyes against claims 52 and 53. The Examiner contends that Reyes teaches that alumina is a well known support material for catalysts. Reyes discloses a multistage catalytic partial oxidation process for oxidizing a hydrocarbon feedstream comprising C₁-C₄ hydrocarbons, with an oxygen-containing feedstream to produce a product comprising CO and H₂. However, Reyes does not suggest conducting the disclosed process in a microchannel, as specified in the Applicants' claims 52 and 53. In fact, the examples disclosed in the reference specify the use of a quartz reactor containing a foam support for the catalyst, the dimensions of the foam support being 0.75 inch (19.05 mm) in diameter by 0.5 inch (12.7 mm) in length. See, Reyes at column 12, lines 52-53; column 13, lines 45-46; and column 14, lines 44-45. The foam supports disclosed in these examples are clearly too large for the microchannel reaction zones specified in the Applicants' claims 52 and 53. Reyes does

not suggest use of the fin assembly specified in claims 52 and 53. Reyes contains no disclosure relating to determining the equilibrium conversion value for a reactant and conducting the reaction in a microchannel wherein each reaction stage is in the same microchannel and the approach to equilibrium is at least about 5% as specified in the Applicants' claims 52 and 53.

The Examiner cites Ghosh against claims 60, 61 and 76. Claims 60, 61 and 76 depend from claim 1. Claim 60 specifies that the contact time in the first reaction zone is from about 10 to about 500 milliseconds. Claim 61 specifies that the contact time in the another reaction zone is from about 10 to about 500 milliseconds. Claim 76 specifies that the contact time with the catalyst in the microchannel reactor is up to about 1,000 milliseconds. Ghosh discloses a reaction chamber for an integrated micro-ceramic chemical plant. In the passage cited by the Examiner (column 1, line 65 to column 2, line 5), Ghosh provides a formula for measuring the degree of mixing based on the reactant diffusion constant for the reactant, the contact time allowed for the mixing, and the distance across a reactant stream. In the example provided in the cited passage, Ghosh indicates that typical near complete mixing of two liquids in one second corresponds to channel widths of 100 microns. This passage has nothing to do with the contact time for a chemical reaction such as specified in the Applicants' claims 60, 61 and 76. The teachings in Ghosh add nothing to the teachings in TeGrotenhuis that would be sufficient to render the Applicants' claims 60, 61, and 76 unpatentable.

Withdrawal of the rejection of claims 1-31, 33-55, 57-72 and 75-79 is believed to be warranted and is respectfully requested.

Applicants respectfully submit that the application is in condition for allowance. A Notice of Allowance is respectfully requested. In the event the Examiner would like to discuss any matters concerning this application, he is invited to contact the undersigned attorney by telephone. Any fees required for the filing of this paper may be charged to Deposit Account Number 18-0988.

Respectfully submitted,

RENNER, OTTO, BOISSELLE & SKLAR, LLP

By: /Neil A. DuChez/
Neil A. DuChez
Reg. No. 26,725

The Keith Building
1621 Euclid Avenue
Nineteenth Floor
Cleveland, Ohio 44115
216/621-1113